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## (54) Title: COMPOSITE STRUCTURES

## (57) Abstract

A sandwich construction comprises two preformed laminates on respective sides of a core material. The laminates are each formed from a synthetic resin and the core material is formed from an inorganic aggregate and a bonding agent, the latter being the same synthetic resin as the preformed laminates. The laminates are moulded to a desired shape and are then used as part of the formwork for moulding of the core material. A strong bond is formed between the laminates and the core material by the use of the same resin, and the method of manufacture provides a saving in manufacturing time and no restriction on varying the thickness of the core material.

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### Composite Structures

This invention relates to a composite material, a structure including such a material, particularly a structure adapted for use where there is a requirement for the structure to be suitable for use in a corrosive environment, and a method of manufacturing the structure.

Laminates made of synthetic resin or plastics combined with reinforcement to provide strength, e.g. GRP (Glass Reinforced Plastics), FRP (Fibre Reinforced Plastics) or Fibreglass, have been known for many years as suitable for use in corrosive areas. Such laminates have very high tensile strength but low stiffness/rigidity. To overcome this and provide a rigid structure, use of a very thick laminate is required, which then has much more tensile strength and corrosion resistance than is needed. As a consequence the structure is expensive when compared to other conventional materials such as stainless steel, aluminium or painted steel.

It has been known that one way to overcome this lack of stiffness is to produce a sandwich construction laminate, i.e. where two layers of laminate are applied or bonded to a low cost core material. Many different materials have been used as the core, such as synthetic foam, honeycomb in paper and aluminium, wood, balsa and paper. The manufacturing procedure is generally to produce one laminate, then position the core material, and then build up or bond the second laminate on top of the core material to form the sandwich construction. With such a procedure, it is difficult to produce complex shapes or to change the thickness of the core to suit variable strength requirements in the same structure.

Another disadvantage of such a manufacturing procedure is in the strength and cost of the core material. To obtain maximum stiffness, the two laminates need to be spaced further apart, with the result that the core material itself needs to be stronger. This increases its cost, and if stronger core

materials are used such as honeycomb, balsa or dense synthetic foams they in turn become more expensive. The time taken in positioning and bonding the core to the first laminate can be disadvantageous, and the bond between the laminates and core material can be a problem.

According to the present invention there is provided a composite material formed by a coalescence of materials in a mould, including an aggregate of materials providing strength and rigidity and a bonding agent. The composite material so formed is hereinafter referred to as a "plastic concrete".

The bonding agent is a thermosetting resin, for example polyester, epoxy, acrylic, vinylester, polyurethane or phenolic, or can be a thermoplastic resin, for example polyvinylchloride, polypropylene or polyurethane. The aggregate can be an inorganic material, for example any of silica sand, silica powder, calcium powder, gravel, stone chippings, ceramic powder or ceramic chippings, or any combination thereof. The plastic concrete may further include glass, metal or plastic fibres.

The present invention also provides a structure comprising a plurality of material layers, a core layer being formed of plastic concrete as hereinbefore defined, and outer layers being formed on respective sides of the core layer, each of the outer layers being formed of a plastics material.

The present invention further provides a method of manufacturing a structure, the method comprising forming a pair of material layers from a plastics material, positioning the material layers in a spaced apart relation, and forming a core layer between the preformed material layers.

The core layer may be formed of plastic concrete as hereinbefore defined and may be introduced in a flowable state between the preformed material layers to be moulded therein. The preformed material layers provide formwork for the moulding. The preformed material layers are moulded and are retained

in their moulds to provide the formwork for moulding of the core layer.

The same synthetic resin may be used for the preformed material layers and the plastic concrete. The plastic concrete may also include glass, metal or plastic fibres.

An embodiment of the present invention will now be described by way of example only.

A structure is formed by producing a sandwich construction in the form of two preformed laminates on respective sides of a core material. The laminates may each be formed from a synthetic resin and the core may be a composite material formed from a plastic concrete as hereinbefore defined, the plastic concrete providing the required stiffness and strength to the structure.

The laminates are moulded to a desired shape and, remaining within their moulds, are then used, in a spaced apart relation, as part of the formwork for the core material. The plastic concrete is poured into the formwork and bonds to the preformed laminates to define the required composite structure.

As the core material can be poured into a mould defined by the preformed laminates so as to bond thereto while setting, there is a saving in manufacturing time, and there is no restriction on changing the thickness of the core in the same structure or changing the shape of the finished structure. Complex shapes can be manufactured, and by using different thicknesses of plastic concrete, the strength can be varied in different areas of the same structure.

The plastic concrete bonding agent may be a synthetic resin such as thermosetting resin, for example polyester, epoxy, acrylic, vinylester, polyurethane or phenolic, or a thermoplastic resin, for example polyvinylchloride, polypropylene or polyurethane. The aggregate can be an organic material, for example any of silica sand, silica powder, calcium powder,

gravel, stone chippings, ceramic powder or ceramic chippings, or any combination thereof. To provide further strength, other types of reinforcement can be included in the plastic concrete, such as glass, metal or plastic fibres. By using the same synthetic resin in forming the laminates and the core, the bond between the laminates and the core can be improved and the core becomes more of an integral part of the laminates.

The core material is low cost because the most expensive material is the synthetic resin which can be as little as 8% of the total weight of the core.

The structure can be used to produce many different structures including pipes, boats, tanks, bridge decks, floor sections, structural beams, manholes, manhole covers and tank covers.

Various modifications may be made without departing from the invention.

CLAIMS

1. A composite material formed by a coalescence of materials in a mould, including an aggregate of materials providing strength and rigidity and a bonding agent.
2. A composite material according to Claim 1, wherein the bonding agent is a thermosetting resin.
3. A composite material according to Claim 2, wherein the thermosetting resin is selected from polyester, epoxy, acrylic, vinylester, polyurethane or phenolic.
4. A composite material according to Claim 1, wherein the resin is a thermoplastic resin.
5. A composite material according to Claim 4, wherein the thermoplastic resin is selected from polyvinylchloride, polypropylene or polyurethane.
6. A composite material according to any of the preceding Claims, wherein the aggregate is an inorganic material.
7. A composite material according to Claim 6, wherein the aggregate is selected from silica sand, silica powder, calcium powder, gravel, stone chippings, ceramic powder or ceramic chippings, or any combination thereof.
8. A composite material according to any of the preceding Claims, including a material selected from glass, metal or plastic fibres.
9. A structure comprising a plurality of material layers, a core layer being formed of a composite material according to any of the preceding Claims, and outer layers being formed on respective sides of the core layer, each of the outer

layers being formed of a plastics material.

10. A structure according to Claim 9, wherein each of the outer layers is formed of a resin.

11. A method of manufacturing a structure, the method comprising forming a pair of material layers from a plastics material, positioning the material layers in a spaced apart relation, and forming a core layer between the preformed material layers.

12. A method according to Claim 11, wherein the core layer is introduced in a flowable state between the preformed material layers to be moulded therein.

13. A method according to Claim 12, wherein the preformed material layers provide formwork for the moulding of the core layer.

14. A method according to Claim 13, wherein the preformed material layers are moulded and are retained in their moulds to provide the formwork for moulding of the core layer.

15. A method according to any of Claims 11 to 14, wherein the core layer includes an aggregate of materials providing strength and rigidity and a bonding agent formed of a resin, and the preformed material layers are formed of the bonding agent resin.

16. A method according to Claim 15, wherein the resin is a thermosetting resin selected from polyester, epoxy, acrylic, vinylester, polyurethane or phenolic.

17. A method according to Claim 15, wherein the resin is a thermoplastic resin selected from polyvinylchloride, polypropylene or polyurethane.

18. A method according to any of Claims 15 to 17, wherein the aggregate is an inorganic material selected from silica sand, silica powder, calcium powder, gravel, stone chippings, ceramic powder or ceramic chippings, or any combination thereof.
19. A method according to any of Claims 15 to 18, wherein the core layer includes a material selected from glass, metal or plastic fibres.
20. A composite material substantially as hereinbefore described.
21. A structure comprising a plurality of material layers substantially as hereinbefore described.
22. A method of manufacturing a structure substantially as hereinbefore described.
23. Any novel subject matter or combination including novel subject matter disclosed herein, whether or not within the scope of or relating to the same invention as any of the preceding claims.

## INTERNATIONAL SEARCH REPORT

Final Application No.  
PCT/GB 98/00565

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 B29C67/24 //B29K503:08, B29L9:00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 B32B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 538 303 A (GIGON MICHEL) 29 June 1984 see page 4, line 26 - page 7, line 16; figure 1 ---	1-3, 6-16, 18
X	EP 0 034 678 A (INA SEITO KK) 2 September 1981 see page 10, line 36 - page 12, line 20; figures 5,6 see page 6, line 8 - line 12 ---	1-3, 6-16, 18
X	EP 0 124 403 A (PLASTREX MANURHIN SARL) 7 November 1984	1-3, 6-10
A	see page 7, line 1 - line 26; figure 1 see page 8, line 7 - line 13 see claim 1 --- -/-	11-16, 18, 19

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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X	EP 0 508 950 A (ALUSUISSE LONZA SERVICES AG) 14 October 1992  see page 4, line 3 - line 18; figure 1 see page 4, line 55 - line 57; figure 4 see page 3, line 4 - line 8 ---	1-6, 8, 9, 11-13, 15-17
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